November Program Highlights

NASA Data Improves Federal Aviation Administration (FAA) Convective Storm Forecasting

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Highlights:

An improvement of *up to* 60 minutes on the first time occurrence of new convective thunderstorm formation forecasting was seen after the integration of a satellite data based algorithm into the forecast system, which RADAR cannot do. The GOES satellite-based 0–1 hour Convective storm Initiation (CI) algorithm named SATCAST, was integrated into a Federal Aviation Administration's 0–2 hour convective weather forecasting system, the Corridor Integrated Weather System (CIWS). CIWS then supplies the 0-2 hour portion of the Consolidated Storm Prediction for Aviation (CoSPA) 0-8 hour forecast system. The use of AIRS soundings was also evaluated as a means of characterizing the pre-storm convective environment, and was shown to add value, especially when numerical weather prediction model forecasts were in error compared to observations.

Relevance:

The significance is that as of June 2011, the SATCAST-enhanced CIWS and CoSPA algorithms were available to traffic flow managers across the United States. Convective weather forecasts in CIWS and CoSPA are improved by a significant amount, especially in regions where no existing radar echoes were present in advance of first-time CI.

Without the prior use of satellite-based CI nowcasts within CIWS and CoSPA, forecasts of new thunderstorms in the 0-1 hour forecast were less skillful, leading to lower lead time notices on blockage of arrival and departure routes near airports and enroute.

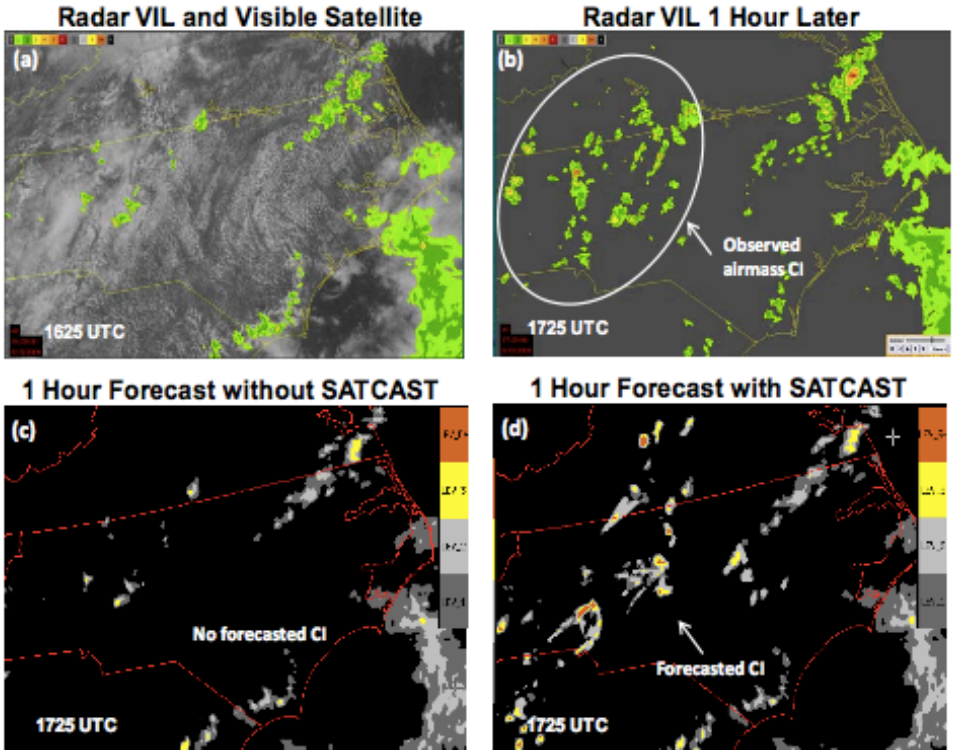

Figure 1: Airmass CI using SATCAST fields within CIWS. In panel (d), improved CI nowcasts are noted as satellite data are used to grow new storms in advance of radar detections.

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Project Summary: To leverage NASA assets to optimize a GOES Convective Initiation (CI) 0-1 hr nowcasting algorithm for performance across various convective regime types, and transition the algorithm into a fielded FAA decision support system (DSS). CI is the first occurrence of ≥35 dBZ echoes from a convective cloud. There is enhanced predictability of the timing, location and growth rate of CI, by more succinctly defining the characteristics of cumulus cloud formation using satellite data. The hypothesis is that this enhanced predictability of CI will lead to more accurate forecasts of the onset and intensity of hazardous convective-scale weather events that impact aviation across large sections of the U.S., as demonstrated through DSS forecasts.

Earth Science Products: AIRS soundings (Level 5 official product) and GOES visible and infrared images (15-minutes resolution). TRMM precipitation radar and CloudSat scan data were used to verify, validate and calibrate the GOES-based convective initiation algorithm when used over oceanic domains.

Technical Description of the Images: Airmass CI using SATCAST fields within CIWS. Panels (a) and (b) show the input GOES and radar data used, which a comparison between panels (c) and (d) demonstrate the improved CI nowcasts that occur when SATCAST's 0-1 hour CI nowcasts are included within CIWS

Application to Decision Making: The main result of this effort was to enhance the 0-1 hour convective initiation algorithm, which was then integrated into CIWS and available for use in CoSPA to increase the accuracy when forecasting new convective storm development. At of 1 June 2011, the SATCAST-enhanced CIWS and CoSPA forecasts were available to traffic flow managers across the U.S.; hence, is providing direct benefit to air travelers on a 24/7 basis, through an improved ability to direct and route flights during convective weather events. Use of NASA data helped increase performance over oceanic regions where radar data were absent in the testing phase.

Scientific Heritage: In 2003, the PI received a NASA New Investigator award, which subsequently led to NASA funding via the Advanced Satellite Aviation Weather Products (ASAP) initiative, which provided support for the development of SATCAST. We were also able to leverage ongoing funding with a partner at NCAR for similar aviation safety-related research, over the lifetime of this project.

References: Papers developed using these funds: (1) Botes, Mecikalski, Jedlovec 2011: Use of AIRS sounding evaluation and analysis of the pre-convective environment. *J. Geophys. Res*. Submitted. (2) Iskenderian, Mecikalski, et al., 2011: Applications of satellite cloud observations to nowcasting convective initiation in aviation weather forecasts. *Bull Amer. Meteorol. Soc*. In preparation. (3) Jewett, et al. 2011: Use of time-space exchangeability to adapt infrared threshold detections of convective initiation. *J. Appl. Meteor. Climatol*. In preparation.

NASA OMI Useful in Emission Observation from New Chinese Coal-Fired Power Plants

David Streets, Argonne National Laboratory

Highlight:

For the first time, satellite retrievals from the Ozone Monitoring Instrument (OMI) on Aura were analyzed to study places where new, large, coal-fired power plants had been recently constructed—the Inner Mongolia region of China, close to extensive coal fields. Good agreement was obtained between emissions calculated from bottom-up inventories and inferred top-down emissions derived from satellite retrievals. For SO2 emissions, the project was even able to deduce whether emission controls were operating as required by the Chinese government. In some cases the project found that the controls came into effect on time; in other case, there seemed to be no effective emission reduction.

Relevance: In many locales and for many kinds of sources, government statistics or in-stack monitors are sufficient to estimate the emissions from the local sources. However, there are other instances, where the necessary statistical information is not available or is unreliable; and therein, the analysis of satellite retrievals can play a role in characterizing emissions. This project demonstrates the strength and reliability of the technique and ultimately should assist in assessing the compliance status of large sources.

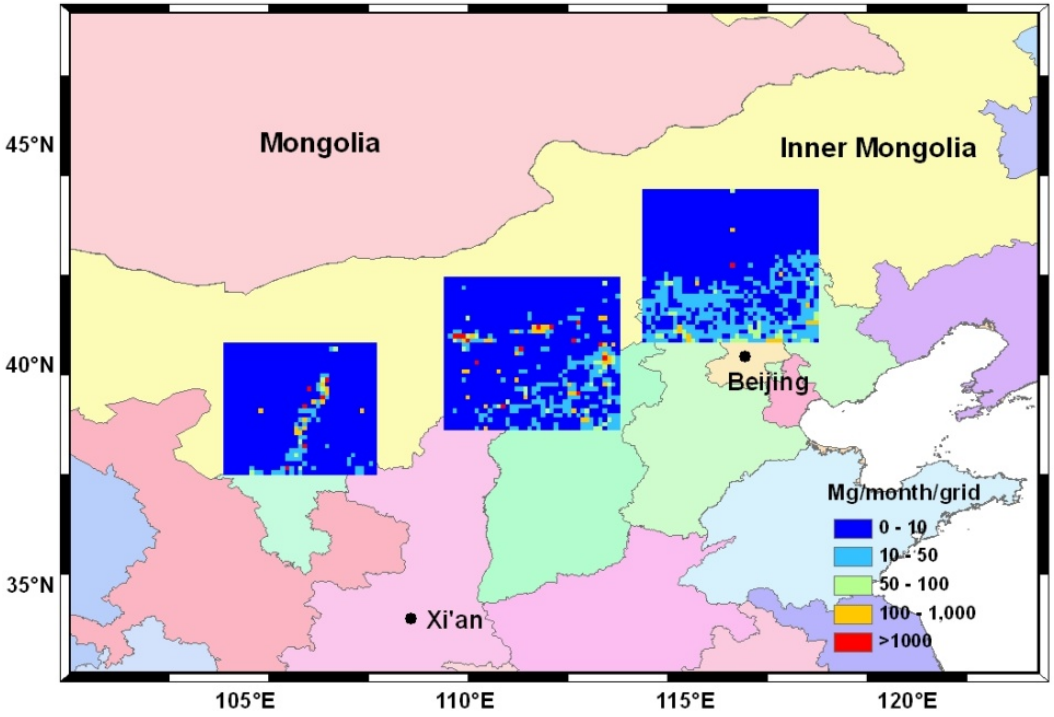

Figure 1: Argonne and NASA/GSFC have been analyzing NO_2 and SO_2 OMI retrievals over Inner Mongolia, China, where 42 new coal-fired power-plant units (16 GW) were installed between 2005 and 2007. Satellites clearly see the increased emissions in the locations where new plants were constructed.

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Project Summary: A systematic analysis framework to provide rapid updates of emission inventories is being developed, demonstrated, and transitioned to operations. The framework combines Earth satellite observations integrated with the Argonne National Laboratory Emission Inventory Model System and community regional air quality models to provide rapid updates of emission inventories. Improved emission estimates are being used in decision support assessments and management actions. including: real-time estimates of emissions and air quality for 2008 Beijing Olympic Games and similar events.

Earth Science Products: Primarily EOS Terra MOPITT CO and Aura/OMI NO_2 and SO_2,

Application to Decision Making: Combining the emissions and air quality modeling activities with satellite products opens new opportunities for decision support. The project believes that we will ultimately be able to determine the compliance status of large sources. This has attracted the interest of the government of China and US EPA, which has never been able to monitor compliance status by other means. The rapid update of emissions enables air quality forecasts to become more accurate and to better utilize this information to educate and protect the public from the impacts of air pollution.

Scientific Heritage: Previous field experiments, including INTEX-B (2006) and ARCTAS (2008), have demonstrated the importance of air quality forecasting in support of field experiments and pointed out the need for rapid update of emissions to reflect current conditions. These experiments have helped to validate and improve the satellite products and brought together the emissions, satellite and modeling personal that has formed the collaboration supported in this project.

References:

Wang, S., D.G. Streets, Q. Zhang, K. He, D. Chen, S. Kang, Z. Lu, and Y. Wang, *Satellite Detection and Model Verification of NO_x Emissions from Power Plants in Northern China*, Environmental Research Letters, *5*, 044007, doi: 10.1088/1748-9326/5/4/044007 (2010).

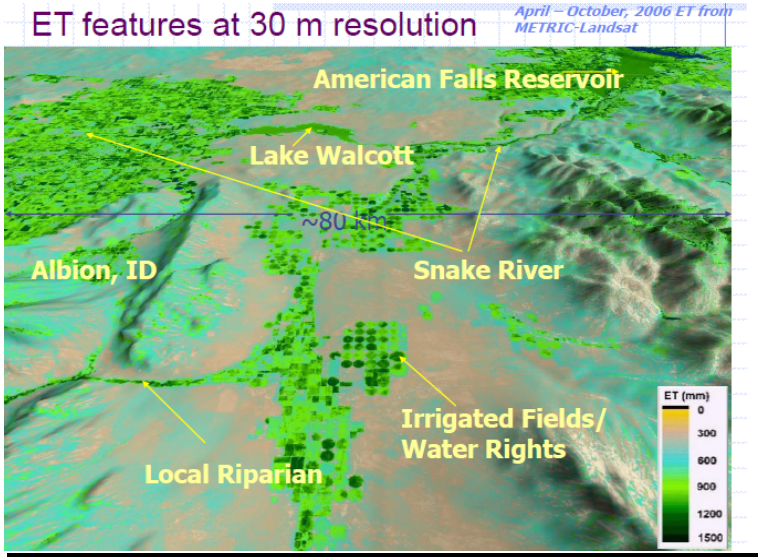
Li, C., Q. Zhang, N.A. Krotkov, D.G. Streets, K. He, S.-C. Tsay, and J.F. Gleason, *Recent Large Reduction in Sulfur Dioxide Emissions from Chinese Power Plants Observed by the Ozone Monitoring Instrument*, Geophysical Research Letters, *37*, L08807, doi: 10.1029/2010GL042594 (2010).

Worden H., Y Cheng, G. Pfister, G. Carmichael, Q. Zhang, D. Streets, M. Deeter, D. Edwards, J. Gille, J. Worden, *Satellite-based estimates of reduced CO and CO_2 emissions due to traffic restrictions during the 2008 Beijing Olympics*, Proceedings of the National Academy of Sciences, in review (2011).

NASA Co-Sponsored "Western States Remote Sensing of Evapotranspiration (ET) " Workshop Held in Boise, ID Oct. 12-13, 2011

- The primary goal of the workshop was to demonstrate the successes of the remote sensing of ET (led by U. Idaho with NASA, USDA, USGS, DRI and others)
- ET can account for 90% of the western US water use and is critical to local economies tied to agriculture, recreation, hydro- power, etc.
- Participants included representatives from nearly all western states (except SD, KS & MT), federal agencies (NASA, NOAA, USDA, USGS) & Western States Water Council. There were 80 + attendees.
- Supported by NASA Topical Workshops, Symposia and Conferences (E.32) & NASA Water Resources. Workshop is a follow-on to NASA-USDA ET Workshop in DC (April 2011).
- Further follow-on and training sessions are planned along with coordination to help promote use of remote sensing technology for western water users. More information at: http://westernstatesetworkshop.com

Landsat derived ET is useful for field scale and water rights evaluation. MODIS ET is useful for regional water resources management.



Figures courtesy of University of Idaho